PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

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(Box PCT)
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Washington, DC 20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 25 June 1997 (25.06.97)	
International application No. PCT/SE96/01578	**Applicant's or agent's file reference** KWP 11113 DE
International filing date (day/month/year) 29 November 1996 (29.11.96)	**Priority date** (day/month/year) 30 November 1995 (30.11.95)
Applicant LINDSKOG, Per et al	

1. The designated Office is hereby notified of its election made:

   [X] in the demand filed with the International Preliminary Examining Authority on:

   06 June 1997 (06.06.97)

   [ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

   [ ] was not

   made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Eugénia Santos

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference AO-11113 DE	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/SE96/01578	International filing date *(day/month/year)* 29.11.1996	Priority date *(day/month/year)* 30.11.1995
International Patent Classification (IPC) or national classification and IPC6 C23C 16/30, 16/40, 30/00, B23B 27/14		
Applicant Sandvik AB (publ) et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☒ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
06.06.1997	10.02.1998
Name and mailing address of the IPEA/SE Patent- och registreringsverket Telex Box 5055 17978 S-102 42 STOCKHOLM PATOREG-S Facsimile No. 08-667 72 88	Authorized officer Ingrid Grundfelt Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SE96/01578

I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

☐ the international application as originally filed.

☒ the description, pages 1-10, as originally filed,
pages _____, filed with the demand,
pages _____, filed with the letter of _____,
pages _____, filed with the letter of _____.

☒ the claims, Nos. _____, as originally filed,
Nos. _____, as amended under Article 19,
Nos. _____, filed with the demand,
Nos. 1-8, filed with the letter of 05.12.1996,
Nos. _____, filed with the letter of _____.

☐ the drawings, ~~sheets~~/fig _____, as originally filed,
~~sheets~~/fig _____, filed with the demand
~~sheets~~/fig _____, filed with the letter of _____,
~~sheets~~/fig _____, filed with the letter of _____.

2. The amendments have resulted in the cancellation of:

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, ~~sheets~~/fig _____

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

V. Resoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-8	YES
	Claims		NO
Inventive step (IS)	Claims		YES
	Claims	1-8	NO
Industrial applicability (IA)	Claims	1-8	YES
	Claims		NO

2. Citations and explanations

The claimed invention relates to a coated cutting tool insert for turning of steel. It also relates to a method for making such an insert by using CVD technique.

The aim of the invention is to achieve excellent cutting properties when using the cutting tool. This is achieved by using a coating containing a $TiC_xN_yO_z$ layer with columnar grains and a top layer having κ - Al_2O_3. These layers are coated on a cemented carbide body with a highly W - alloyed binder phase having an innermost layer of $TiC_xN_yO_z$ with equiaxed grains. The chemical compostion as well as the grain size of the WC - grains are held within specific intervals. The top layer may contain 1-3 vol-% of the θ - or the α - phases, cf. p.4, lines 13-15.

Claim 1 EP, A2, 0 685 572 (see claims 1, 8 and 12, p.4, line 39, p.5, lines 38-41 and p.17) discloses a cutting tool based on WC. The content of Co could be 4-12 wt-%, i.e. a content falling approximately within the limits prescribed in present claim 1. The contents of Ti, Ta and/or Nb are of the same order of magnitude as those stated in claim 1. This tool, which is useful for machining of steel, is coated with layers of the kind stated in claim 1 and applied in the same order.

Thus, it is previously known to deposit a layer of $TiC_xN_yO_z$, which has columnar structure (cf. the expression "unilaterally grown crystals of an elongated shape" in claim 1 of the cited document), on a layer not having a columnar structure and to deposit an outer layer of κ - Al_2O_3 (or a mixture of κ - Al_2O_3 and α - Al_2O_3) on top of these layers (cf. p.4, lines 13-15 in the present description). The thicknesses claimed in present claim 1 appear not differ from those disclosed in EP, A2, 0 685 572 (see p.3, line 40 - p.4, line 29).

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

EP, A1, 0 709 484 describes a similar coated cutting tool based on WC (see p.2, lines 30-52, p.4 and table 2). In this cutting tool the W and Co are diffused into the ground boundaries of the first and second layers. However, both the type of layers as in the present case and the order between them are known from this document.

Investigating and specifying the parameters according to any of the documents cited above is considered to be an obvious measure for a person skilled in the art. Therefore, claim 1 lacks an inventive step with respect to any of the documents cited above.

EP, A1, 0 686 707 (see p.2, lines 1-18, p.4, lines 9-12 and claim 1) reveals a cutting tool based on WC for machining of steel, which is coated with layers of the kind stated in claim 1. This document does not explicitly mention that any of the $TiC_xN_yO_z$ layers described in the document has columnar grains, but according to the tables 1-5 and 9-13 a TiCN layer could be produced by using acetonitrile in the gas composition. According to the present description p.5, lines 3-11, EP, A2, 0 685 572 (see p.3, lines 21-29), EP, A1, 0 709 484 (see p.4, lines 6-14) and EP, A1, 0 653 499 (see p.13, lines 1-41), these columnar layers are produced by using a gas composition containing acetonitrile. Using the knowledge from EP, A2, 0 685 572, EP, A1, 0 709 484 and EP, A1, 0 653 499, a person skilled in the art would be able to produce a columnar layer also in the invention according to EP, A1, 0 686 707.

Therefore, claim 1 does not involve an inventive step with respect to EP, A1, 0 686 707 in combination with either EP, A2, 0 685 572, EP, A1, 0 709 484 or EP, A1, 0 653 499.

Furthermore, the invention according to claim 1 is considered to be obvious for a person skilled in the art with respect to Patent Abstracts of Japan, abstract of JP, A, 6 108 254, publ. 1994-04-19 & JP, A, 6 108 254 in combination with EP, A1, 0 408 535, EP, A2, 0 685 572 and EP, A1, 0 686 707, see next paragraph.

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

JP, A, 6 108 254 (see abstract and table on p.3) describes a cutting tool based on WC. The content of Co could be e.g. 8 or 9 wt-%, i.e. a content falling within the limits prescribed in present claim 1. This tool is coated with layers of the kind stated in claim 1. According to the abstract of JP, A, 6 108 254, the first layer consists of TiN. The next layer, which has columnar structure, consists of TiCN. Further layers of one or more of TiCO, TiCON and Al_2O_3 could be deposited on top of these layers, cf. example 7 on p.6 and 9 in the Japanese document. The invention according to present claim 1 differs from what is disclosed in the Japanese document in that the content of cubic carbides is lower (0.2-1.8 wt-%) than in the Japanese document. Trying other contents of cubic carbides, choosing specifically κ - Al_2O_3 and using the tool insert for turning of steels is considered to be obvious for a person skilled in the art; cf. EP, A1, 0 408 535 (see col.1, lines 5-12 and col.5, line 56-col.6, line 25), EP, A2, 0 685 572 (see p.4, line 39) and EP, A1, 0 686 707 (see abstract, p.2, lines 1-18 and p.4, lines 9-12).Thus, claim 1 lacks an inventive step also with respect to these documents.

Claims 2, 3 Applying a thin TiN layer on top of an Al_2O_3 layer and removing layers along a cutting edge are previously known, cf. EP, A2, 0 685 572 (see p.4, lines 5-8) and US, A, 4 643 620 (see abstract, col.2, lines 8-30, col.3, lines 42-44, col.3, lines 59-66 and fig 5C). It is considered to be obvious for a person skilled in the art to apply this technique in present case. Therefore, claims 2 and 3 do not involve an inventive step.

Claims 4-8 Concerning claims 4-8, see the discussion above for claims 1-3.

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date (valid claim) *(day/month/year)*
EP,A1, 0693574	24.01.1996	18.07.1995	20.07.1994

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure *(day/month/year)*	Date of written disclosure referring to non-written disclosure *(day/month/year)*

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claim 1 does not state the meaning of x, y and z (cf. claim 4).

Claims 1 and 4 do not state the grain size of the WC grains in the layers, cf. p.3, lines 23-26 and p.4, lines 30-31. Statements on surface roughness are missing, cf. p.4, lines 19-22.

Claim 4 does not state that the cutting insert is useful for turning of steels, cf. claim 1. Neither does this claim state the contents of Co and cubic carbides in the tool insert, cf. claim 1. The meaning of the expressions "known CVD-methods and MTCVD-technique" is not clear. The lower limit for the temperature interval is not consistent with the description p.5, line 9. Claim 5 lacks a statement on how the κ - Al_2O_3 is produced.

Claims

1. A cutting tool insert particularly for turning of steel comprising a cemented carbide body and a coating c h a r a c t e r i s e d in that said cemented carbide body consists of WC, 6-15, preferably 9-12, wt-% Co and 0.2-1.8 wt-% cubic carbides of Ti, Ta and/or Nb and a highly W-alloyed binder phase with a CW-ratio of 0.78-0.93, preferably 0.80-0.91 and in that said coating comprises

- a first (innermost) layer of $TiC_xN_yO_z$ with a thickness of <1.5 µm, and with equiaxed grains with size <0.5 µm

- a layer of $TiC_xN_yO_z$ with a thickness of 2-5 µm with columnar grains with an average diameter of <5 µm

- an outer layer of a smooth, fine-grained (0.5-2 µm) κ-Al_2O_3-layer with a thickness of 0.5-6 µm.

2. Cutting insert according to any of the preceding claims c h a r a c t e r i s e d in that the outermost layer is a thin 0.1-1 µm TiN-layer.

3. Cutting insert according to claim 2 c h a r a c t e r i s e d in that the outermost TiN-layer has been removed along the cutting edge.

4. Method of making an insert for turning comprising a cemented carbide body and a coating c h a r a c t e r i z e d in that a WC-Co-based cemented carbide body with a highly W-alloyed binder phase with a CW-ratio of 0.78-0.93 is coated with

- a first (innermost) layer of $TiC_xN_yO_z$ with x+y+z=1, preferably z<0.5, with a thickness of 0.1-1.5 µm, with equiaxed grains with size <0.5 µm using known CVD-methods

- a layer of $TiC_xN_yO_z$ with x+y+z=1, preferably with z=0 and x>0.3 and y>0.3, with a thickness of 2-8 µm with columnar grains with a diameter of about <5 µm deposited by MTCVD-technique, using acetonitrile as the carbon and

nitrogen source for forming the layer in a preferred temperature range of 850-900 °C.

- a layer of a smooth κ-Al_2O_3 with a thickness of 0.5-6 μm and
- preferably a layer of TiN with a thickness of <1 μm.

5. Method according to the previous claim characterized in that said cemented carbide body has a cobalt content of 9-12 wt% and 0.4-1.8 wt% cubic carbides of Ta and Nb.

6. Method according to claim 4 or 5 characterised in that said cemented carbide body has a cobalt content of 10-11 wt%.

7. Method according to claim 4, 5 or 6 characterized in a CW-ratio of 0.82-0.90.

8. Method according to any of the claims 4, 5, 6 and 7 characterized in that the outermost TiN-layer, if present, is removed along the cutting edge.

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International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
C23C 16/30, 16/40, 30/00, B23B 27/14

A1

(11) International Publication Number: **WO 97/20082**

(43) International Publication Date: 5 June 1997 (05.06.97)

(21) International Application Number: PCT/SE96/01578

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(30) Priority Data:
9504304-8 30 November 1995 (30.11.95) SE
9602413-8 17 June 1996 (17.06.96) SE

(71) Applicant *(for all designated States except US)*: SANDVIK AB, (publ) [SE/SE]; S-811 81 Sandviken (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: LINDSKOG, Per [SE/SE]; Staffan Stallares Väg 17, S-125 35 Älvsjö (SE). GUSTAFSON, Per [SE/SE]; Segerminnesvägen 37, S-141 40 Huddinge (SE). LJUNGBERG, Björn [SE/SE]; Kulstötarvägen 96, S-122 44 Enskede (SE). ÖSTLUND, Åke [SE/SE]; Sedelvägen 12, S-129 32 Hägersten (SE).

(74) Agents: ÖSTLUND, Alf et al.; Sandvik AB (publ), Patent Dept., S-811 81 Sandviken (SE).

(81) Designated States: BR, CN, IL, JP, KR, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: COATED TURNING INSERT AND METHOD OF MAKING IT

(57) Abstract

The present invention discloses a coated turning insert particularly useful for turning in stainless steel. The insert is characterised by a WC-Co-based cemented carbide substrate having a highly W-alloyed Co-binder phase and a coating including an inner layer of $TiC_xN_yO_z$ with columnar grains followed by a layer of fine grained κ-Al_2O_3 and a top layer of TiN. The layers are deposited by using CVD-methods.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/01578

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C23C 16/30, C23C 16/40, C23C 30/00, B23B 27/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: C23C, B23B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0685572 A2 (MITSUBISHI MATERIALS CORPORATION), 6 December 1995 (06.12.95), page 3, line 21 - page 4, line 39; page 17, claims 1,8,12 --	1-8
Y	EP 0709484 A1 (MITSUBISHI MATERIALS CORPORATION), 1 May 1996 (01.05.96), page 2, line 30 - line 52; page 4; page 6 --	1-8
Y	EP 0686707 A1 (MITSUBISHI MATERIALS CORPORATION), 13 December 1995 (13.12.95), page 2, line 1 - line 18; page 4, line 9 - line 12, claim 1 --	1-8

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 February 1997	01 -03- 1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Ingrid Grundfelt Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/01578

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0653499 A1 (SUMITOMO ELECTRIC INDUSTRIES, LTD.), 17 May 1995 (17.05.95), page 13, line 1 - line 41	1-8
Y	Patent Abstracts of Japan, Vol 18,No 392, C-1228, abstract of JP,A,6-108254 (MITSUBISHI MATERIALS CORP), 19 April 1994 (19.04.94), & JP,A, 6-108254 (see p. 3)	1-8
Y	EP 0408535 A1 (SECO TOOLS AB), 16 January 1991 (16.01.91), column 1, line 5 - line 12; column 5, line 56 - column 6, line 25	1-8
Y,P	EP 0693574 A1 (SANDVIK AKTIEBOLAG), 24 January 1996 (24.01.96), claims 5,6	3,8
Y	US 4643620 A (HIROSHI FUJII ET AL), 17 February 1987 (17.02.87), column 2, line 8 - line 30; column 3, line 42 - line 44; column 3, line 59 - line 66, figure 5C, abstract	3,8

INTERNATIONAL SEARCH REPORT

Information on patent family members

03/02/97

International application No.
PCT/SE 96/01578

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A2- 0685572	06/12/95	CN-A- 1121537	01/05/96
		JP-A- 7331443	19/12/95
		JP-A- 7328808	19/12/95
		JP-A- 7328809	19/12/95
		JP-A- 7328810	19/12/95
		JP-A- 8001408	09/01/96
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EP-A1- 0709484	01/05/96	JP-A- 8118105	14/05/96
		JP-A- 8118108	14/05/96
		JP-A- 8187605	23/07/96
		JP-A- 8187606	23/07/96
EP-A1- 0686707	13/12/95	JP-A- 6190605	12/07/94
EP-A1- 0653499	17/05/95	JP-C- 1441045	30/05/88
		JP-A- 58031118	23/02/83
		JP-B- 62050570	26/10/87
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		WO-A- 9428191	08/12/94
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		DE-D,T- 69007885	28/07/94
		JP-A- 3138368	12/06/91
		US-A- 5137774	11/08/92
		US-A- 5162147	10/11/92
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		CN-A- 1116571	14/02/96
		IL-D- 114674	00/00/00
		JP-A- 8052603	27/02/96
		SE-A- 9402543	21/01/96

INTERNATIONAL SEARCH REPORT

Information on patent family members

03/02/97

International application No.
PCT/SE 96/01578

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4643620	17/02/87	AU-B- 581847	09/03/89
		AU-A- 2855984	29/11/84
		EP-A,B- 0127416	05/12/84
		SE-T3- 0127416	
		JP-A- 59219122	10/12/84
		US-A- 4755399	05/07/88

Claims

1. A cutting tool insert particularly for turning of steel comprising a cemented carbide body and a coating c h a r a c t e r i s e d in that said cemented carbide body consists of WC, 6-15, preferably 9-12, wt-% Co and 0.2-1.8 wt-% cubic carbides of Ti, Ta and/or Nb and a highly W-alloyed binder phase with a CW-ratio of 0.78-0.93, preferably 0.80-0.91 and in that said coating comprises

- a first (innermost) layer of $TiC_xN_yO_z$ with a thickness of <1.5 µm, and with equiaxed grains with size <0.5 µm

- a layer of $TiC_xN_yO_z$ with a thickness of 2-5 µm with columnar grains with an average diameter of <5 µm

- an outer layer of a smooth, fine-grained (0.5-2 µm) κ-Al_2O_3-layer with a thickness of 0.5-6 µm.

2. Cutting insert according to any of the preceding claims c h a r a c t e r i s e d in that the outermost layer is a thin 0.1-1 µm TiN-layer.

3. Cutting insert according to claim 2 c h a r a c t e r i s e d in that the outermost TiN-layer has been removed along the cutting edge.

4. Method of making an insert for turning comprising a cemented carbide body and a coating c h a r a c t e r i z e d in that a WC-Co-based cemented carbide body with a highly W-alloyed binder phase with a CW-ratio of 0.78-0.93 is coated with

- a first (innermost) layer of $TiC_xN_yO_z$ with x+y+z=1, preferably z<0.5, with a thickness of 0.1-1.5 µm, with equiaxed grains with size <0.5 µm using known CVD-methods

- a layer of $TiC_xN_yO_z$ with x+y+z=1, preferably with z=0 and x>0.3 and y>0.3, with a thickness of 2-8 µm with columnar grains with a diameter of about <5 µm deposited by MTCVD-technique, using acetonitrile as the carbon and

nitrogen source for forming the layer in a preferred temperature range of 850-900 °C.

- a layer of a smooth κ-Al_2O_3 with a thickness of 0.5-6 μm and
- preferably a layer of TiN with a thickness of <1 μm.

5. Method according to the previous claim characterized in that said cemented carbide body has a cobalt content of 9-12 wt% and 0.4-1.8 wt% cubic carbides of Ta and Nb.

6. Method according to claim 4 or 5 characterised in that said cemented carbide body has a cobalt content of 10-11 wt%.

7. Method according to claim 4, 5 or 6 characterized in a CW-ratio of 0.82-0.90.

8. Method according to any of the claims 4, 5, 6 and 7 characterized in that the outermost TiN-layer, if present, is removed along the cutting edge.

09/077424

PATENT COOPERATION TREATY

PCT

19 MAR 1998

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference AO-11113 DE	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/SE96/01578	International filing date *(day/month/year)* 29.11.1996	Priority date *(day/month/year)* 30.11.1995
International Patent Classification (IPC) or national classification and IPC6 C23C 16/30, 16/40, 30/00, B23B 27/14		
Applicant Sandvik AB (publ) et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☒ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
06.06.1997	10.02.1998
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Telex 17978 PATOREG-S Facsimile No. 08-667 72 88	Authorized officer Ingrid Grundfelt Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SE96/01578

I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

☐ the international application as originally filed.

☒ the description, pages 1-10, as originally filed,
pages _____, filed with the demand,
pages _____, filed with the letter of _____,
pages _____, filed with the letter of _____.

☒ the claims, Nos. _____, as originally filed,
Nos. _____, as amended under Article 19,
Nos. _____, filed with the demand,
Nos. 1-8, filed with the letter of 05.12.1996,
Nos. _____, filed with the letter of _____.

☐ the drawings, ~~sheets~~/fig _____, as originally filed,
~~sheets~~/fig _____, filed with the demand
~~sheets~~/fig _____, filed with the letter of _____,
~~sheets~~/fig _____, filed with the letter of _____.

2. The amendments have resulted in the cancellation of:

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, ~~sheets~~/fig _____

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

V. Resoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-8	YES
	Claims		NO
Inventive step (IS)	Claims		YES
	Claims	1-8	NO
Industrial applicability (IA)	Claims	1-8	YES
	Claims		NO

2. Citations and explanations

The claimed invention relates to a coated cutting tool insert for turning of steel. It also relates to a method for making such an insert by using CVD technique.

The aim of the invention is to achieve excellent cutting properties when using the cutting tool. This is achieved by using a coating containing a $TiC_xN_yO_z$ layer with columnar grains and a top layer having κ - Al_2O_3. These layers are coated on a cemented carbide body with a highly W - alloyed binder phase having an innermost layer of $TiC_xN_yO_z$ with equiaxed grains. The chemical compostion as well as the grain size of the WC - grains are held within specific intervals. The top layer may contain 1-3 vol-% of the θ - or the α - phases, cf. p.4, lines 13-15.

Claim 1 EP, A2, 0 685 572 (see claims 1, 8 and 12, p.4, line 39, p.5, lines 38-41 and p.17) discloses a cutting tool based on WC. The content of Co could be 4-12 wt-%, i.e. a content falling approximately within the limits prescribed in present claim 1. The contents of Ti, Ta and/or Nb are of the same order of magnitude as those stated in claim 1. This tool, which is useful for machining of steel, is coated with layers of the kind stated in claim 1 and applied in the same order.

Thus, it is previously known to deposit a layer of $TiC_xN_yO_z$, which has columnar structure (cf. the expression "unilaterally grown crystals of an elongated shape" in claim 1 of the cited document), on a layer not having a columnar structure and to deposit an outer layer of κ - Al_2O_3 (or a mixture of κ - Al_2O_3 and α - Al_2O_3) on top of these layers (cf. p.4, lines 13-15 in the present description). The thicknesses claimed in present claim 1 appear not differ from those disclosed in EP, A2, 0 685 572 (see p.3, line 40 - p.4, line 29).

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

EP, A1, 0 709 484 describes a similar coated cutting tool based on WC (see p.2, lines 30-52, p.4 and table 2). In this cutting tool the W and Co are diffused into the ground boundaries of the first and second layers. However, both the type of layers as in the present case and the order between them are known from this document.

Investigating and specifying the parameters according to any of the documents cited above is considered to be an obvious measure for a person skilled in the art. Therefore, claim 1 lacks an inventive step with respect to any of the documents cited above.

EP, A1, 0 686 707 (see p.2, lines 1-18, p.4, lines 9-12 and claim 1) reveals a cutting tool based on WC for machining of steel, which is coated with layers of the kind stated in claim 1. This document does not explicitly mention that any of the $TiC_xN_yO_z$ layers described in the document has columnar grains, but according to the tables 1-5 and 9-13 a TiCN layer could be produced by using acetonitrile in the gas composition. According to the present description p.5, lines 3-11, EP, A2, 0 685 572 (see p.3, lines 21-29), EP, A1, 0 709 484 (see p.4, lines 6-14) and EP, A1, 0 653 499 (see p.13, lines 1-41), these columnar layers are produced by using a gas composition containing acetonitrile. Using the knowledge from EP, A2, 0 685 572, EP, A1, 0 709 484 and EP, A1, 0 653 499, a person skilled in the art would be able to produce a columnar layer also in the invention according to EP, A1, 0 686 707.

Therefore, claim 1 does not involve an inventive step with respect to EP, A1, 0 686 707 in combination with either EP, A2, 0 685 572, EP, A1, 0 709 484 or EP, A1, 0 653 499.

Furthermore, the invention according to claim 1 is considered to be obvious for a person skilled in the art with respect to Patent Abstracts of Japan, abstract of JP, A, 6 108 254, publ. 1994-04-19 & JP, A, 6 108 254 in combination with EP, A1, 0 408 535, EP, A2, 0 685 572 and EP, A1, 0 686 707, see next paragraph.

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

JP, A, 6 108 254 (see abstract and table on p.3) describes a cutting tool based on WC. The content of Co could be e.g. 8 or 9 wt-%, i.e. a content falling within the limits prescribed in present claim 1. This tool is coated with layers of the kind stated in claim 1. According to the abstract of JP, A, 6 108 254, the first layer consists of TiN. The next layer, which has columnar structure, consists of TiCN. Further layers of one or more of TiCO, TiCON and Al_2O_3 could be deposited on top of these layers, cf. example 7 on p.6 and 9 in the Japanese document. The invention according to present claim 1 differs from what is disclosed in the Japanese document in that the content of cubic carbides is lower (0.2-1.8 wt-%) than in the Japanese document. Trying other contents of cubic carbides, choosing specifically κ - Al_2O_3 and using the tool insert for turning of steels is considered to be obvious for a person skilled in the art; cf. EP, A1, 0 408 535 (see col.1, lines 5-12 and col.5, line 56-col.6, line 25), EP, A2, 0 685 572 (see p.4, line 39) and EP, A1, 0 686 707 (see abstract, p.2, lines 1-18 and p.4, lines 9-12).Thus, claim 1 lacks an inventive step also with respect to these documents.

Claims 2, 3 Applying a thin TiN layer on top of an Al_2O_3 layer and removing layers along a cutting edge are previously known, cf. EP, A2, 0 685 572 (see p.4, lines 5-8) and US, A, 4 643 620 (see abstract, col.2, lines 8-30, col.3, lines 42-44, col.3, lines 59-66 and fig 5C). It is considered to be obvious for a person skilled in the art to apply this technique in present case. Therefore, claims 2 and 3 do not involve an inventive step.

Claims 4-8 Concerning claims 4-8, see the discussion above for claims 1-3.

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date (valid claim) *(day/month/year)*
EP,A1, 0693574	24.01.1996	18.07.1995	20.07.1994

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure *(day/month/year)*	Date of written disclosure referring to non-written disclosure *(day/month/year)*

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claim 1 does not state the meaning of x, y and z (cf. claim 4).

Claims 1 and 4 do not state the grain size of the WC grains in the layers, cf. p.3, lines 23-26 and p.4, lines 30-31. Statements on surface roughness are missing, cf. p.4, lines 19-22.

Claim 4 does not state that the cutting insert is useful for turning of steels, cf. claim 1. Neither does this claim state the contents of Co and cubic carbides in the tool insert, cf. claim 1. The meaning of the expressions "known CVD-methods and MTCVD-technique" is not clear. The lower limit for the temperature interval is not consistent with the description p.5, line 9. Claim 5 lacks a statement on how the κ - Al_2O_3 is produced.

PATENT COOPERATION TREATY

PTO/PCT Rec'd 28 MAY 1998

PCT

INTERNATIONAL SEARCH REPORT

09/077424

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference KWP 11113 DE	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/SE 96/01578	International filing date *(day/month/year)* 29 November 1996	(Earliest) Priority Date *(day/month/year)* 30 November 1995
Applicant Sandvik AB (publ) et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. [ ] Certain claims were found unsearchable (See Box I).

2. [ ] Unity of invention is lacking (See Box II).

3. [ ] The international application contains disclosure of a nucleotide and/or amino acid sequence listing and the international search was carried out on the basis of the sequence listing
   - [ ] filed with the international application.
   - [ ] furnished by the applicant separately from the international application,
     - [ ] but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
   - [ ] transcribed by this Authority.

4. With regard to the title,
   - [ ] the text is approved as submitted by the applicant.
   - [X] the text has been established by this Authority to read as follows:

     Coated turning insert and method of making it.

5. With regard to the abstract,
   - [ ] the text is approved as submitted by the applicant.
   - [X] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is:

   Figure No. ---
   - [ ] as suggested by the applicant.
   - [ ] because the applicant failed to suggest a figure.
   - [ ] because this figure better characterizes the invention.
   - [ ] None of the figures.

International application No.
PCT/SE96/01578

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

The present invention discloses a coated turning insert particularly useful for turning in stainless steel. The insert is characterised by a WC-Co-based cemented carbide substrate having a highly W-alloyed Co-binder phase and a coating including an inner layer of $TiC_xN_yO_z$ with columnar grains followed by a layer of fine grained κ-Al_2O_3 and a top layer of TiN. The layers are deposited by using CVD-methods.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/01578

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C23C 16/30, C23C 16/40, C23C 30/00, B23B 27/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: C23C, B23B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0685572 A2 (MITSUBISHI MATERIALS CORPORATION), 6 December 1995 (06.12.95), page 3, line 21 - page 4, line 39; page 17, claims 1,8,12 --	1-8
Y	EP 0709484 A1 (MITSUBISHI MATERIALS CORPORATION), 1 May 1996 (01.05.96), page 2, line 30 - line 52; page 4; page 6 --	1-8
Y	EP 0686707 A1 (MITSUBISHI MATERIALS CORPORATION), 13 December 1995 (13.12.95), page 2, line 1 - line 18; page 4, line 9 - line 12, claim 1 --	1-8

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 February 1997	01 -03- 1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Ingrid Grundfelt Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/01578

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0653499 A1 (SUMITOMO ELECTRIC INDUSTRIES, LTD.), 17 May 1995 (17.05.95), page 13, line 1 - line 41 --	1-8
Y	Patent Abstracts of Japan, Vol 18,No 392, C-1228, abstract of JP,A,6-108254 (MITSUBISHI MATERIALS CORP), 19 April 1994 (19.04.94), & JP,A, 6-108254 (see p. 3) --	1-8
Y	EP 0408535 A1 (SECO TOOLS AB), 16 January 1991 (16.01.91), column 1, line 5 - line 12; column 5, line 56 - column 6, line 25 --	1-8
Y,P	EP 0693574 A1 (SANDVIK AKTIEBOLAG), 24 January 1996 (24.01.96), claims 5,6 --	3,8
Y	US 4643620 A (HIROSHI FUJII ET AL), 17 February 1987 (17.02.87), column 2, line 8 - line 30; column 3, line 42 - line 44; column 3, line 59 - line 66, figure 5C, abstract --	3,8

INTERNATIONAL SEARCH REPORT
Information on patent family members

03/02/97

International application No.
PCT/SE 96/01578

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A2- 0685572	06/12/95	CN-A-	1121537	01/05/96
		JP-A-	7331443	19/12/95
		JP-A-	7328808	19/12/95
		JP-A-	7328809	19/12/95
		JP-A-	7328810	19/12/95
		JP-A-	8001408	09/01/96
		JP-A-	8001409	09/01/96
		JP-A-	8001410	09/01/96
		JP-A-	8001411	09/01/96
		JP-A-	8090311	09/04/96
EP-A1- 0709484	01/05/96	JP-A-	8118105	14/05/96
		JP-A-	8118108	14/05/96
		JP-A-	8187605	23/07/96
		JP-A-	8187606	23/07/96
EP-A1- 0686707	13/12/95	JP-A-	6190605	12/07/94
EP-A1- 0653499	17/05/95	JP-C-	1441045	30/05/88
		JP-A-	58031118	23/02/83
		JP-B-	62050570	26/10/87
		JP-A-	7100701	18/04/95
		WO-A-	9428191	08/12/94
		JP-A-	7285001	31/10/95
EP-A1- 0408535	16/01/91	SE-T3-	0408535	
		DE-D,T-	69007885	28/07/94
		JP-A-	3138368	12/06/91
		US-A-	5137774	11/08/92
		US-A-	5162147	10/11/92
EP-A1- 0693574	24/01/96	BR-A-	9503375	12/03/96
		CN-A-	1116571	14/02/96
		IL-D-	114674	00/00/00
		JP-A-	8052603	27/02/96
		SE-A-	9402543	21/01/96

INTERNATIONAL SEARCH REPORT
Information on patent family members

03/02/97

International application No.
PCT/SE 96/01578

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4643620	17/02/87	AU-B- 581847	09/03/89
		AU-A- 2855984	29/11/84
		EP-A,B- 0127416	05/12/84
		SE-T3- 0127416	
		JP-A- 59219122	10/12/84
		US-A- 4755399	05/07/88

The demand must be filed directly with the competent International Preliminary Examining Authority. If two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ _____

PCT

DEMAND

CHAPTER II

under Article 31 of the Patent Cooperation Treaty:
The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty.

For International Preliminary Examining Authority use only

Identification of IPEA	Date of receipt of DEMAND

Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION

Applicant's or agent's file reference: **AO-11113 DE**

International application No.	International filing date (*day/month/year*)	(Earliest) Priority date (*day/month/year*)
PCT/SE96/01578	29.11.96	30.11.95

Title of invention: Coated Turning Insert

Box No. II APPLICANT(S)

Name and address: (*Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.*)

SANDVIK AB; (publ)
SE-811 81 SANDVIKEN
Sweden

Telephone No.: +46-26-260000
Facsimile No.: +46-26-261089
Teleprinter No.: 47000 sandvik s

State (*i.e. country*) of nationality:	State (*i.e. country*) of residence:
Sweden	Sweden

Name and address: (*Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.*)

LINDSKOG Per
Staffan Stallares Väg 17
S-125 35 ÄLVSJÖ
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State (*i.e. country*) of nationality:	State (*i.e. country*) of residence:
Sweden	Sweden

Name and address: (*Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.*)

GUSTAFSON Per
Segerminnesvägen 37
S-141 40 HUDDINGE
Sweden

State (*i.e. country*) of nationality:	State (*i.e. country*) of residence:
Sweden	Sweden

☒ Further applicant(s) and/or (further) inventor(s) are indicated on a continuation sheet.

International application No.
PCT/SE96/01578

Continuation of Box No. II APPLICANT(S)

If none of the following sub-boxes is used, this sheet is not to be included in the demand.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

LJUNGBERG Björn
Kulstötarvägen 96
S-122 44 ENSKEDE
Sweden

State *(i.e. country)* of nationality:	State *(i.e. country)* of residence:
Sweden	Sweden

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

ÖSTLUND Åke
Sedelvägen 12
S-129 32 HÄGERSTEN
Sweden

State *(i.e. country)* of nationality:	State *(i.e. country)* of residence:
Sweden	Sweden

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State *(i.e. country)* of nationality:	State *(i.e. country)* of residence:

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State *(i.e. country)* of nationality:	State *(i.e. country)* of residence:

☐ Further applicant(s) and/or (further) inventor(s) are indicated on another continuation sheet.

International application No.
PCT/SE96/01578

Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The following persons are ☒ agents ☐ common representative

and ☒ have been appointed earlier and represents the applicant(s) also for international preliminary examination.

☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.

☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

ÖSTLUND Alf or TÅQUIST Lennart
both of

Sandvik AB, Patent Dept
SE-811 81 SANDVIKEN
Sweden

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Facsimile No.
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Teleprinter No.
47000 sandvik s

☐ Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead toindicate a special address to which correspondence should be sent.

Box No. IV STATEMENT CONCERNING AMENDMENTS

The applicant wishes the International Preliminary Examining Authority*

(i) ☒ to start the international preliminary examination on the basis of the international application as originally filed.

(ii) ☐ to take into account the amendments under Article 34 of

- ☐ the description (amendments attached).
- ☐ the claims (amendments attached).
- ☐ the drawings (amendments attached).

(iii) ☐ to take into account any amendments of the claims under Article 19 filed with the International Bureau (a copy is attached).

(iv) ☐ to disregard any amendments of the claims made under Article 19 and consider them as reversed.

(v) ☐ to postpone the start of the international preliminary examination until the expiration of 20 months from the priority date unless that Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired).*

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Box No. V ELECTION OF STATES

☒ The applicant hereby elects all eligible States *(that is, all States which have been designated and which are bound by Chapter II of the PCT)* except .....

.....

.....

.....

(If the applicant does not wish to elect certain eligible States, the name(s) or country code(s) of those States must be indicated above.)

International application No.
PCT/SE96/01578

Box No. VI CHECK LIST

The demand is accompanied by the following documents for the purposes of international preliminary examination

			For International Preliminary Examining Authority use only: received	not received
1. amendments under Article 34				
description	:	sheets	☐	☐
claims	:	sheets	☐	☐
drawings	:	sheets	☐	☐
2. letter accompanying amendments under Article 34	:	sheets	☐	☐
3. copy of amendments under Article 19	:	sheets	☐	☐
4. copy of statement under Article 19	:	sheets	☐	☐
5. other *(specify):*	:	sheets	☐	☐

The demand is also accompanied by the item(s) marked below:

1. ☐ separate signed power of attorney
2. ☐ copy of general power of attorney
3. ☐ statement explaining lack of signature
4. ☐ fee calculation sheet
5. ☐ other *(specify):*

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious fro reading the demand).

Sandviken, Sweden June 5, 1997

SANDVIK AB; (publ)

Alf Östlund

Lennart Taqvist

For International Preliminary Examining Authority use only

1. Date of actual receipt of DEMAND:
2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):
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(54) Title: COATED TURNING INSERT AND METHOD OF MAKING IT

(57) Abstract

The present invention discloses a coated turning insert particularly useful for turning in stainless steel. The insert is characterised by a WC-Co-based cemented carbide substrate having a highly W-alloyed Co-binder phase and a coating including an inner layer of $TiC_xN_yO_z$ with columnar grains followed by a layer of fine grained κ-Al_2O_3 and a top layer of TiN. The layers are deposited by using CVD-methods.

COATED TURNING INSERT AND METHOD OF MAKING IT

The present invention relates to a coated cutting tool (cemented carbide insert) particularly useful for wet turning of toughness demanding stainless steels components like square bars, flanges and tubes, with raw surfaces such as cast skin, forged skin, hot or cold rolled skin or pre-machined surfaces.

When turning stainless steels with cemented carbide tools the cutting edge is worn according to different wear mechanisms, such as adhesive wear, chemical wear, abrasive wear and by edge chipping caused by cracks formed along the cutting edge, the so called comb cracks.

Different cutting conditions require different properties of the cutting insert. For example, when cutting in steels with raw surface zones a coated cemented carbide insert must consist of a tough carbide and have very good coating adhesion. When turning in stainless steels the adhesive wear is generally the dominating wear type.

Measures can be taken to improve the cutting performance with respect to a specific wear type. However, very often such action will have a negative effect on other wear properties.

So far it has been very difficult to improve all tool properties simultaneously. Commercial cemented carbide grades have therefore been optimised with respect to one or few of the wear types and hence to specific application areas.

Swedish patent application 9503056-5 discloses a coated cutting insert particularly useful for turning in hot and cold forged low alloyed steel components. The inserts is characterised by a cemented carbide substrate consisting of Co-WC and cubic carbides having a 15-35 µm

thick surface zone depleted from cubic carbides, a coating including a layer of $TiC_xN_yO_z$ with columnar grains, a layer of smooth, fine grained κ-Al_2O_3, and preferably an outer layer of TiN.

Swedish patent application 9504304-8 discloses a coated cutting insert particularly useful for wet and dry milling of low and medium alloyed steels. The insert is characterised by a cemented carbide substrate consisting of Co-WC and cubic carbides, a coating including a layer of $TiC_xN_yO_z$ with columnar grains, a layer of smooth, fine grained κ-Al_2O_3 and preferably an outer layer of TiN.

It has now been found that combinations of the substrates and coatings described in the above patent applications give rise to excellent cutting performance in stainless steels turning. A cemented carbide substrate with a cubic carbide depleted surface zone combined with a coating in accordance with patent application, 9503056-5, has been found to be especially suitable for high speed turning in easy stainless steel, such as turning of machineability improved 304L, In more difficult work piece materials such as 316-Ti and in operations with a high degree of thermal cycling such as turning of square bars a straight WC-Co substrate of the type described in patent application 9504304-8 has been found the most suitable.

A turning tool insert according to the invention useful for turning of steel consists of a cemented carbide substrate with a highly W-alloyed binder phase and with a well balanced chemical composition and grain size of the WC, a columnar $TiC_xN_yO_z$-layer, a κ-Al_2O_3-layer, a TiN-layer and optionally followed by smoothening the cutting edges by brushing the edges with e.g. a SiC based brush.

The cobalt binder phase is highly alloyed with W. The content of W in the binder phase can be expressed as the CW-ratio= M_S / (wt% Co · 0.0161), where M_S is the measured saturation magnetisation of the cemented carbide substrate in kA/m and wt% Co is the weight percentage of Co in the cemented carbide. The CW-value is a function of the W content in the Co binder phase. A low CW-value corresponds to a high W-content in the binder phase. According to the present invention improved cutting performance is achieved if the cemented carbide substrate has a CW-ratio of 0.78-0.93.

According to the present invention a turning tool insert is provided particularly useful for difficult stainless steel turning is provided with a cemented carbide substrate with a composition of 6-15 wt% Co, preferably 9-12 wt% Co, most preferably 10-11 wt% Co, 0.2-1.8 wt% cubic carbides, preferably 0.4-1.8 wt% cubic carbides, most preferably 0.5-1.7 wt% cubic carbides of the metals Ta, Nb and Ti and balance WC. The cemented carbide may also contain other carbides from elements from group IVb, Vb or VIb of the periodic table. The content of Ti is preferably on a level corresponding to a technical impurity. The preferred average grain size of the WC depend on the binder phase content. At the preferred composition of 10-11 wt-% Co, the preferred grain size is 1.5-2 µm, most preferably about 1.7 µm. The CW-ratio shall be 0.78-0.93, preferably 0.80-0.91, and most preferably 0.82-0.90. The cemented carbide may contain small amounts, <1 volume %, of η-phase (M_6C), without any detrimental effect. From the CW-value it follows that no free graphite is allowed in the cemented carbide substrate according to the present embodiment.

The coating comprises

- a first (innermost) layer of $TiC_xN_yO_z$ with x+y+z=1, preferably z<0.5, with equiaxed grains with

size <0.5 μm and a total thickness <1.5 μm and preferably >0.1 μm.

- a layer of $TiC_xN_yO_z$ with x+y+z=1, preferably with z=0 and x>0.3 and y>0.3, with a thickness of 1-15 μm, preferably 2-8 μm, with columnar grains and with an average diameter of <5 μm, preferably 0.1-2 μm. Most preferred thickness of the $TiC_xN_yO_z$ layer is 2-5 μm, particularly in extremely edgeline-toughness demanding work-piece materials such as Ti-stabilised stainless steel.

- a layer of a smooth, fine-grained (grain size about 0.5-2 μm) Al_2O_3 consisting essentially of the κ-phase. However, the layer may contain small amounts, 1-3 vol-%, of the θ- or the α-phases as determined by XRD-measurement. The Al_2O_3-layer has a thickness of 0.5-6 μm, preferably 0.5-3 μm, and most preferably 0.5-2 μm. Preferably, this Al_2O_3-layer is followed by a further layer (<1 μm, preferably 0.1-0.5 μm thick) of TiN, but the Al_2O_3 layer can be the outermost layer. This outermost layer, Al_2O_3 or TiN, has a surface roughness R_{max}<0.4 μm over a length of 10 μm. The TiN-layer, if present, is preferably removed along the cutting edge.

According to the method of the invention a WC-Co-based cemented carbide substrate is made with a highly W-alloyed binder phase with a CW-ratio of 0.78-0.93, preferably 0.80-0.91, and most preferably 0.82-0.90, a content of cubic carbides of 0.2-1.8 wt%, preferably 0.4-1.8 wt%, most preferably 0.5-1.7 wt% of the metals Ta, Nb and Ti, with 6-15 wt% Co, preferably 9-12 wt% Co, most preferably 10-11 wt% Co at which Co-content the WC grain size 1.5-2 μm, most preferably about 1.7 μm. The body is coated with:

- a first (innermost) layer of $TiC_xN_yO_z$ with x+y+z=1, preferably z<0.5, with a thickness of <1.5 μm,

and with equiaxed grains with size <0.5 µm using known CVD-methods.

- a layer of $TiC_xN_yO_z$ x+y+z=1, preferably with z=0 and x >0.3 and y>0.3, with a thickness of 1-13 µm, preferably 2-8 µm, with columnar grains and with an average diameter of <5 µm, preferably <2 µm, using preferably MTCVD-technique (using acetonitrile as the carbon and nitrogen source for forming the layer in the temperature range of 700-900 °C). The exact conditions, however, depend to a certain extent on the design of the equipment used.

- a smooth Al_2O_3-layer essentially consisting of κ-Al_2O_3 is deposited under conditions disclosed in e.g. EP-A-523 021. The Al_2O_3 layer has a thickness of 0.5-6 µm, preferably 0.5-3 µm, and most preferably 0.5-2 µm. Preferably, a further layer (<1 µm, preferably 0.1-0.5 µm thick) of TiN is deposited, but the Al_2O_3 layer can be the outermost layer. This outermost layer, Al_2O_3 or TiN, has a surface roughness R_{max}<0.4 µm over a length of 10 µm. The smooth coating surface can be obtained by a gentle wet-blasting the coating surface with fine grained (400-150 mesh) alumina powder or by brushing (preferably used when TiN top coating is present) the edges with brushes based on SiC as disclosed in Swedish patent application 9402543-4. The TiN-layer, if present, is preferably removed along the cutting edge.

Example 1

A. A cemented carbide turning tool insert in style CNMG120408-MM with the composition 10.5 wt-% Co, 1.16 wt-% Ta, 0.28 wt-% Nb and balance WC, with a binder phase highly alloyed with W corresponding to a CW-ratio of 0.87, was coated with an innermost 0.5 µm equiaxed TiCN-layer with a high nitrogen content, corresponding to an estimated C/N ratio of 0.05, followed by a 4.3 µm

thick layer of columnar TiCN deposited using MT-CVD technique. In subsequent steps during the same coating process a 1.1 µm layer of Al_2O_3 consisting of pure κ-phase according to procedure disclosed in EP-A-523 021. A thin, 0.5 µm, TiN layer was deposited, during the same cycle, on top of the Al_2O_3-layer. The coated insert was brushed by a SiC containing nylon straw brush after coating, removing the outer TiN layer on the edge.

B. A cemented carbide turning tool insert in style CNMG120408-MM with the composition of 7.5 wt-% Co, 1.8 wt-% TiC, 3.0 wt-% TaC, 0.4 wt-% NbC, balance WC and a CW-ratio of 0.88. The cemented carbide had a surface zone, about 25 µm thick, depleted from cubic carbides. The insert was coated with an innermost 0.5 µm equiaxed TiCN-layer with a high nitrogen content, corresponding to an estimated C/N ratio of 0.05, followed by a 7.2 µm thick layer of columnar TiCN deposited using MT-CVD technique. In subsequent steps during the same coating process a 1.2 µm layer of Al_2O_3 consisting of pure κ-phase according to procedure disclosed in EP-A-523 021. A thin, 0.5 µm, TiN layer was deposited, during the same cycle, on top of the Al_2O_3-layer. The coated insert was brushed by a SiC containing nylon straw brush after coating, removing the outer TiN layer on the edge.

C. A competitive cemented carbide turning tool insert in style CNMG120408 from an external leading cemented carbide producer was selected for comparison in a turning test. The carbide had a composition of 9.0 wt-% Co, 0.2 wt-% TiC, 1.7 wt-% TaC, 0.2 wt-% NbC, balance WC and a CW-ratio of 0.90. The insert had a coating consisting of 1.0 µm TiC, 0.8 µm TiN, 1.0 µm TiC and, outermost, 0.8 µm TiN. Examination in light optical microscope revealed no edge treatment subsequent to coating.

D. A competitive cemented carbide turning tool insert in style CNMG120408 from an external leading cemented carbide producer was selected for comparison in a turning test. The cemented carbide had a composition of 5.9 wt-% Co, 3.1 wt-% TiC, 5.6 wt-% TaC, 0.1 wt-% NbC, balance WC and a CW-ratio of 0.95. The cemented carbide had a surface zone, about 30 µm thick, which was enriched in Co content. The insert had a coating consisting of 5.3 µm TiC, 3.6 µm TiCN, outermost, 2.0 µm TiN. Examination in light optical microscope revealed no edge treatment subsequent to coating.

E. A competitive cemented carbide turning tool insert in style CNMG120408 from an external leading cemented carbide producer was selected for comparison in a turning test. The carbide had a composition of 8.9 wt-% Co, balance WC and a CW-ratio of 0.84. The insert had a coating consisting of 1.9 µm TiC, 1.2 µm TiN, 1.5 µm Al_2O_3 laminated with 3 0.1 µm tick layers of TiN and, outermost, 0.8 µm TiN. Examination in light optical microscope revealed no edge treatment subsequent to coating.

F. A competitive cemented carbide turning tool insert in style CNMG120408 from an external leading cemented carbide producer was selected for comparison in a turning test. The carbide had a composition of 5.4 wt-% Co, 2.7 wt-% TiC, 3.5 wt-% TaC, 2.3 wt-% NbC, balance WC and a CW-ratio of 0.94. The cemented carbide had a surface zone, about 40 µm thick, which was enriched in Co content. The insert had a coating consisting of 5.3 µm TiC, 3.6 µm TiCN, outermost, 2.0 µm TiN. Examination in light optical microscope revealed no edge treatment subsequent to coating.

Inserts from A, B, C, D, E and F were compared in facing of a bar, diameter 180, with two, opposite, flat

sides (thickness 120 mm) in 4LR60 material. Feed 0.25 mm/rev, speed 180 m/min and depth of cut 2.0 mm.

The wear mechanism in this test is chipping of the edge. The inserts with gradient substrates (B, E and F) looked good after three cuts but broke suddenly after about four.

Insert	Number of cuts
A (acc. to invent.)	15
B (outside invention)	5
C (external grade)	9
D (external grade)	9
E (external grade)	4
F (external grade)	4

Example 2

Inserts A, and B from above were selected for a turning test, longitudinal and facing in machineability improved AISI304L stainless steel.

Cutting speed was 250 m/min, feed 0.3 mm/rev and depth of cut 2 mm. Cutting time 1 minute/cycle.

The wear mechanism was plastic deformation.

Insert	Number of cycles
B (outside invention)	7
A (acc. to invent.)	4

Example 3

G. Inserts in geometry TNMG160408-MM with composition and coating according to A above.

H. Inserts in geometry TNMG160408-MM with composition and coating according to B above.

I. Inserts in geometry TNMG160408 with composition and coating according to C above.

The inserts G, H and I were tested in longitudinal, dry, turning of a shaft in duplex stainless steel.

Feed 0.3 mm/rev, speed 140 m/min and depth of cut 2 mm. Total cutting time per component was 12 minutes.

Insert G and I got plastic deformation whereas insert H got some notch wear.

Two edges of insert G were worn out to produce one component whereas one edge of insert H completed one component and four edges were required to finalise one component using insert I.

Insert	Number of edges/component
H (outside invention)	1
G (acc. to invent.)	2
I (external grade)	4

Example 4

Inserts A and E from above were selected for a turning test, mainly facing, in a cover rotorcase made in cast AISI316 stainless steel. The cutting was interrupted due to component design.

Cutting speed was 180 m/min, feed 0.2 mm/rev and depth of cut 0-2 mm (irregular shape of casting). Cutting time 10.5 minutes/component.

The wear mechanism was a combination of edge chipping and plastic deformation.

Insert	Number of components
A (acc. to invent.)	2
E (external grade)	1

Example 5

Inserts according to A, B, C and D were selected for a turning test. Internal turning of AISI304 stainless steel valve substrate. Cutting speed was 130 m/min and feed 0.4 mm/rev. The stability was poor due to the boring bar.

The wear was chipping of the edge for inserts D and B whereas inserts A and C got plastic deformation.

Insert	Number of components
A (acc. to invent.)	9
D (external grade)	7
C (external grade)	5
B (outside invention)	2

Example 6

Inserts A and C from above were selected for a turning test, roughing of a square bar in AISI316Ti stainless steel. The cutting was interrupted due to component design.

Cutting speed was 142 m/min, feed 0.2 mm/rev, depth of cut 4 mm. and cutting time 0.13 minutes/component.

The wear was chipping of the edge.

Insert	Number of components
A (acc. to invent.)	25
C (external grade)	15

Claims

1. A cutting tool insert particularly for turning of steel comprising a cemented carbide body and a coating c h a r a c t e r i s e d in that said cemented carbide body consists of WC, 6-15, preferably 9-12, wt-% Co and 0.2-1.8 wt-% cubic carbides of Ti, Ta and/or Nb and a highly W-alloyed binder phase with a CW-ratio of 0.78-0.93, preferably 0.80-0.91 and in that said coating comprises

- a first (innermost) layer of $TiC_xN_yO_z$ with a thickness of <1.5 µm, and with equiaxed grains with size <0.5 µm

- a layer of $TiC_xN_yO_z$ with a thickness of 2-5 µm with columnar grains with an average diameter of <5 µm

- an outer layer of a smooth, fine-grained (0.5-2 µm) κ-Al_2O_3-layer with a thickness of 0.5-6 µm.

2. Cutting insert according to any of the preceding claims c h a r a c t e r i s e d in that the outermost layer is a thin 0.1-1 µm TiN-layer.

3. Cutting insert according to claim 2 c h a r a c t e r i s e d in that the outermost TiN-layer has been removed along the cutting edge.

4. Method of making an insert for turning comprising a cemented carbide body and a coating c h a r a c t e r i z e d in that a WC-Co-based cemented carbide body with a highly W-alloyed binder phase with a CW-ratio of 0.78-0.93 is coated with

- a first (innermost) layer of $TiC_xN_yO_z$ with x+y+z=1, preferably z<0.5, with a thickness of 0.1-1.5 µm, with equiaxed grains with size <0.5 µm using known CVD-methods

- a layer of $TiC_xN_yO_z$ with x+y+z=1, preferably with z=0 and x>0.3 and y>0.3, with a thickness of 2-8 µm with columnar grains with a diameter of about <5 µm deposited by MTCVD-technique, using acetonitrile as the carbon and

nitrogen source for forming the layer in a preferred temperature range of 850-900 °C.

- a layer of a smooth κ-Al_2O_3 with a thickness of 0.5-6 μm and
- preferably a layer of TiN with a thickness of <1 μm.

5. Method according to the previous claim characterized in that said cemented carbide body has a cobalt content of 9-12 wt% and 0.4-1.8 wt% cubic carbides of Ta and Nb.

6. Method according to claim 4 or 5 characterised in that said cemented carbide body has a cobalt content of 10-11 wt%.

7. Method according to claim 4, 5 or 6 characterized in a CW-ratio of 0.82-0.90.

8. Method according to any of the claims 4, 5, 6 and 7 characterized in that the outermost TiN-layer, if present, is removed along the cutting edge.